

# **FY03 Technical Program Summary**

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### **Vehicle Technology Directorate - Langley Site US Army Research Laboratory at NASA Langley Research Center Hampton, VA 23681-0001**

The ARL Vehicle Technology Directorate at the Langley Research Center conducts research in two business areas:

Structural Mechanics and  
Loads & Dynamics

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

#### **Aviation Structural Mechanics Research - 6.1 - 61102 / AH66 / VS1011**

VS1011.CA01	Reliability-Based Design of Composite Shells
VS1011.CA02	Coupled Meshless-Finite Element Methods for Structural Mechanics
VS1011.IF01	Delamination Characterization
VS1011.IF02	Composite Low-Velocity Impact Analysis and Testing
VS1011.IF03	Small Crack-Growth Effects in Metallic Materials
VS1011.IF06	Tension-Torsion Fatigue of Composite Flexbeam Laminates
VS1011.IF07	Tension-Bending Behavior of Tapered Composite Laminates
VS1011.IM01	Threshold Fatigue Crack Growth of Metallic Materials
VS1011.IM02	Probabilistic Analysis of Fatigue Crack Initiation and Propagation

Aviation Loads & Dynamics Research - 6.1 - 61102 / AH66 / VS1015

VS1015.AA01	Fundamental Studies of Elastically Coupled Structures
VS1015.AL05	Analytical Aeroelastic Modeling of Advanced Rotor Configurations
VS1015.AL06	High Performance Piezoelectric Actuator Development
VS1015.AL07	Lightweight Multifunctional Structural Components Development
VS1015.AR01	Structural and Material Characteristics of Biological Morphologies
VS1015.DC01	Crashworthiness of Composite Frames and Floor Sections

Ground Vehicle Loads & Dynamics Research - 6.1 - 61102 / AH42 / VS1016

VS1016.DC02	Nonlinear Mechanics of Elastomeric and Composite Structures
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Aviation Structural Mechanics Technology - 6.2 - 62211 / A47B / VS2011

VS2011.CA01	Probabilistic and Non-Deterministic Methods for Structural Design
VS2011.CA02	SARAP Crash Safety Research Program
VS2011.CD01	Research on Advanced Aircraft Structural Concepts
VS2011.IC01	SARAP Low-Velocity Impact Damage Tolerance of Sandwich Composites
VS2011.IC02	Skin/Stiffener Debonding Analysis Methods
VS2011.IC03	Exploratory Research on Adaptive Sensors for Composite Rotorcraft
VS2011.IF04	Z-pin Reinforcement Analysis
VS2011.IF08	Fatigue Life Methodology of Metallic Rotorcraft Dynamic Components
VS2011.IF11	Impact Damage Resistance & Tolerance of Thin Skin Composite Sandwich Structure
VS2011.IF12	Reliability-Based Design Methods
VS2011.IN01	Composite Thermal Nondestructive Evaluation
VS2011.IN07	SARAP NDE/Reparability Program

Ground Vehicle Structural Mechanics Technology - 6.2 - 62105 / AH84 / VS2012

VS2012.CA01	Research on Ground Combat Vehicles
VS2012.CA02	Buckling - Vibration Interaction
VS2012.CD01	Selective Reinforcement of Aluminum Structures
VS2012.CD02	Multi-Functional Structures
VS2012.IN07	NDE of Composite Structures Using Laser Ultrasonics
VS2012.IN12	NDE of Electrical Wire Insulation Using Ultrasonics

Aviation Loads & Dynamics Technology - 6.2 - 62211 / A47B / VS2015

VS2015.AA02	High-Speed Aeroelastic Research Models
VS2015.AA04	ARES Enhancements/Projection Moire Interferometry
VS2015.AE02	Regenerative Electronics
VS2015.AL04	Experimental Investigation of Active Twist Rotor Concepts for Vibratory Load Reduction
VS2015.AL05	Analysis and Design of Active Twist Rotor Blades
VS2015.DA02	Adaptive Structural Morphing Kinematics
VS2015.DC08	Innovative Composite Fuselage Design for Improved Crashworthiness
VS2015.DC09	Soft Soil - Water Impact
VS2015.DC10	Crash Resistant Fuel Systems (CRFS)
VS2015.DC11	Crash Simulation of an ATR42 Aircraft
VS2015.DC12	Fokker F-28 Crash Test Support
VS2015.DT01	Applications of Structural Tailoring Concepts

Ground Vehicle Loads & Dynamics Technology - 6.2 - 62105 / AH84 / VS2016

VS2016.DR08	Ground Vehicle Mobility
VS2016.DR10	Inflatable Structures
VS2016.DR14	Modeling of Thin Membrane Structures

**BUSINESS SUBAREA:** 6.1 LOADS & DYNAMICS

**PE/PRJ/WP#/WP:** 61102 AH42 VS1016 Ground Vehicle Loads & Dynamics Research

**DIRECTORATE/DIVISION** Vehicle Technology Directorate Loads & Dynamics

**POC/PHONE:** Wolf Elber 757-864-3949

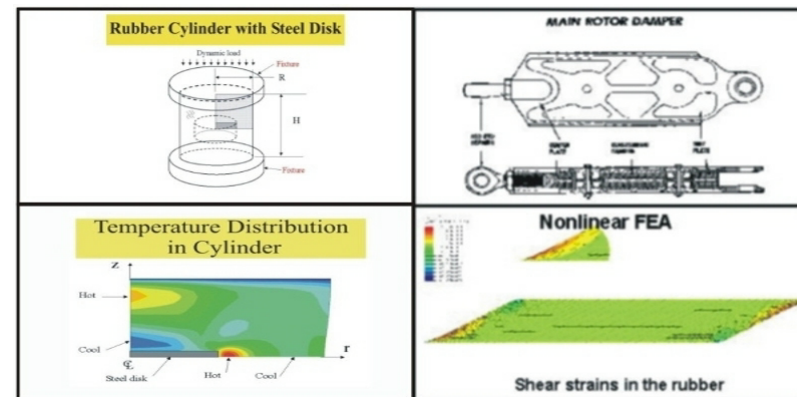
**Date Last Modified:** 30-OCT-02

#### THRUST:

Develop and enhance analytical models for multi-body kinematics and dynamics to support vehicle loads analysis and vibration reduction.  
Improve constitutive modeling and implementation of viscoelastic structures, and calibrate their performance with experimental data.

#### OBJECTIVES:

Increase performance capability of non-aviation related structural concepts with reduced weight by tailoring the structure for dynamic response.  
Develop techniques for incorporating smart material effects in structural components in Finite Element Analysis modeling.  
Improve computational models (NASA finite element method for modeling tires) by incorporating the dynamic properties of rubber materials.  
Build a technology base from which the next generation of finite element models for rubber material structures can be developed.



#### PROGRAM SCHEDULE:

	2002	2003	2004	2005	2006
<b>RESEARCH STUDIES</b>					
<b>Nonlinear Mechanics of Elastomeric and Composite Str</b>	****	****	****	****	****

#### FY03 KEY DELIVERABLES:

- \* Continue work on time-space FEA of viscous beams and plates. Collaborate with Brunel University on adaptive methods for materials with memory (ARO contract.)
- \* Continue support to Editorial Board of Rubber Chemistry and Technology. Organize a session for the Fall 03 ACS Rubber Division Meeting.

**Business SUBAREA:** 6.1

**LOADS & DYNAMICS**

**PE/PRJ/WP#/WP:** 61102

AH42

VS1016

Ground Vehicle Loads & Dynamics Research

Workyears	2002	2003	2004	2005	2006
ARMY	.95	.95	.95	.95	.95
NASA	.05	.05	.05	.05	.05
OTHER	.4	.4	.4	0	0

**LOADS & DYNAMICS**

**OBJECTIVE**

The objective of this basic research program is to focus on improved methods for predicting the structural response of load carrying elastomer components, particularly for application to vehicle classes other than rotorcraft. However recent interest in viscoelastic "lead-lag" dampers for helicopter rotor system applications have opened a new area of fundamental research. The thrust of this research is to lighten and improve the durability of high performance tires, tank track pads, and other elastomeric items used as structural components used by the Army, Navy, Air Force, and dual-use civilian vehicles by improved computational methods for predicting the response and failure of these elastomeric load carrying load components. In addition, as resources permit, improvements in multi-body dynamic analyses are critical to understanding the non-linear environment of many of our Army vehicles.

**APPROACH**

The approach involves development of new constitutive theories, which allow for efficient computational modeling of large strain rubber viscoelastic deformations. Applications exist for technology enhancement to support the rubber industry to model viscoelastic effects. The current capability is limited to small dynamic strains superimposed on large static strain. Interaction with the International community in viscoelastic methodology is increasing with particular emphasis on Brunel University in the U.K. Potential University interaction in the U.S., now includes those historically rotorcraft related functions particularly focusing on rotorcraft viscoelastic "lead-lag" damper technology. The leverage and connectivity with NASA is substantial in that the researchers involved in these programs are an integral part of the NASA branches and are able to apply the NASAs research programs in structural dynamics programs to specific Army interests. VSD research is also closely aligned to the Army Research Office, the Army Rotorcraft Centers, and other academic institutions.

**SIGNIFICANCE**

The ultimate payoff of this joint Army/NASA structural dynamics research will be a better understanding of the dynamic modeling of viscoelastic and multi-body structures in Army ground vehicles, and more effective methods for their prediction. This fundamental research supports DOD Technology Objective: Demonstration of Advanced Rotor Concepts (DARC), the Armys Science and Technology Objectives: Advanced Rotorcraft Aeromechanics Technologies (ARCAT) and Variable Geometry Advanced Technologies (VGART).